Temperature, clipping, and drought effects on belowground bud outgrowth of invasive *Bromus inermis* and native *Pascopyrum smithii*

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Introduction

In the perennial grasslands of the Great Plains, most stems are recruited from the belowground bud bank rather than from seed. Therefore, bud banks are the mechanism through which plant populations persist and grasslands respond to drivers, such as grazing, fire, and climate. Major drivers of northern mixed-grass prairie include livestock grazing and occasional drought but now these native prairie communities are facing increasing stresses as temperatures rise due to climate change and exotic grasses, such as *Bromus inermis* (smooth brome), invade. The transition of buds to tillers (i.e. bud outgrowth or tiller initiation) and tiller survival are vital to maintaining successful vegetative reproduction and resilient native perennial grasslands.

Objective

To examine the mechanism by which key grass populations respond to climate and grazing, bud outgrowth responses to temperature and drought of an invasive (*B. inermis)* and a dominant native rhizomatous grass (*Pascopyrum smithii,* western wheatgrass*)* were studied in a series of growth chamber experiments. The effect of grazing on bud outgrowth was also examined for *P. smithii*.

Methods

In May 2014, 175 individual plants of *B. inermis* from 10 clones and 350 individual plants of *P. smithii* were randomly selected and harvested from a pasture on the Buffalo Gap National Grassland (Photo1). All individuals were kept in their native soil at 4 C in the dark until they were placed in the growth chamber. By conducting12 2-week growth chamber trials, four experiments were completed.

Experiment 1: Temperature and Species

Each species was evaluated under well-watered conditions at three temperature regimens (4 replicates each): Low (10 C night/16 C day), Medium (16 C/22 C), and High (22 C/ 28 C).

Experiment 2: Moisture and Species

In the four low temperature growth chamber trials, a drought treatment was added for both species. Drought pots were watered every four days with the same total amount of water as non-drought pots received over the previous four days. Drought pots experienced a long period of dry down reaching ~20-22% VWC followed by a rapid saturation event.

Experiment 3: Temperature and Clip

A clipped treatment was applied to an additional set of *P. smithii* plants at each temperature. Plants were clipped to a 4cm height to simulate grazing.

Experiment 4: Moisture and Clip

At the lowest temperature, the effect of soil moisture and clipping on bud outgrowth was examined for *P. smithii*.

At the end of each trial, buds and tillers of each plant were counted, assessed to be living or dead, and classified by developmental stage and size class (Plate 1).

Photo 1. Collecting samples of *B. inermis* and *P. smithii* on the Buffalo Gap National Grasslands near Fairburn, SD.

Experiment 1: Temperature & Species

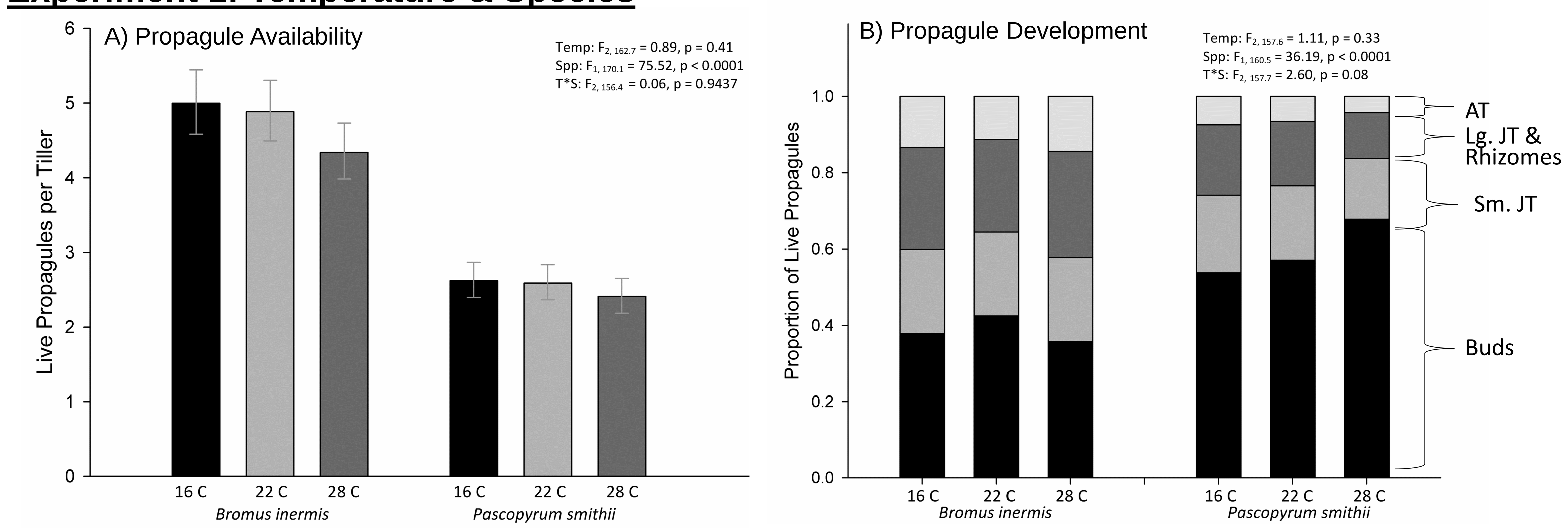

Figure 1. A) Live propagules per tiller and B) Propagule development according to temperature and species under well-watered conditions. *Bromus inermis* naturally produces a greater number of buds per tiller than *P. smithii* . At all temperatures, insignificant numbers of propagules died per tiller. Therefore, *B. inermis* maintained a greater number of live propagules per tiller than *P.smithii. Bromus inermis* initiated a greater proportion of buds to tiller thus producing a more developed propagule bank at all temperatures than *P. smithii* .

Experiment 2: Moisture & Species

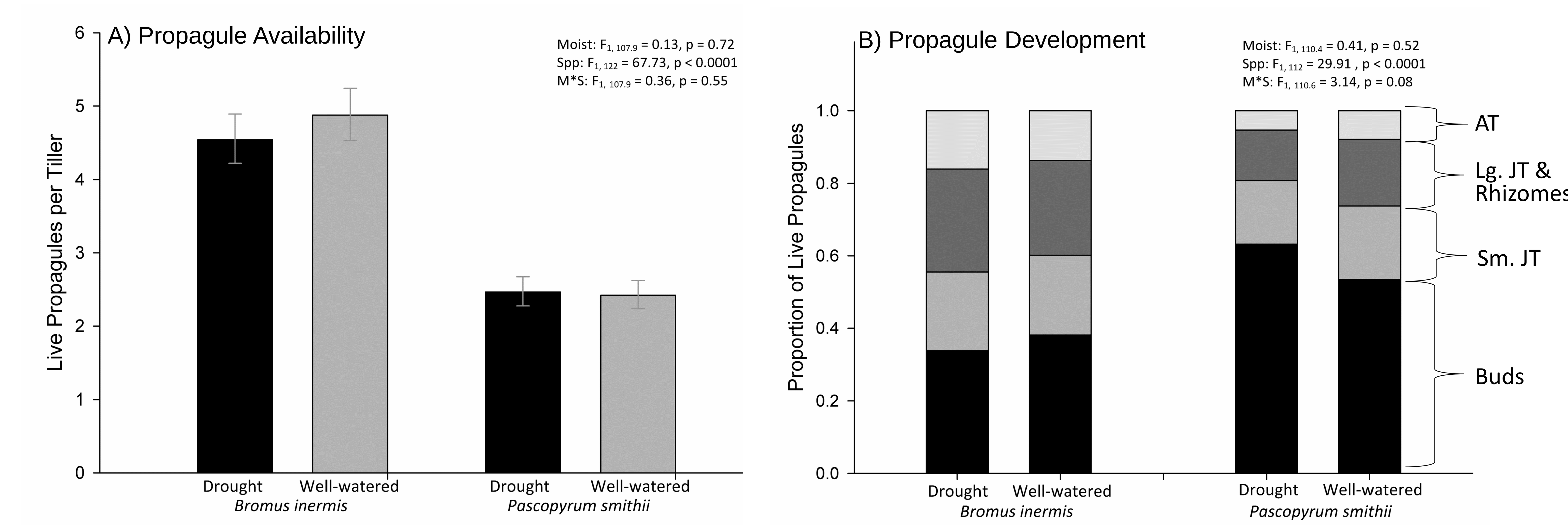

Figure 2. A) Live propagules per tiller and B) Propagule development according to moisture and species at the low temperature. Species differences observed in Experiment 1 were maintained during short-term drought. Drought did not affect bud outgrowth.

Experiment 3: Temperature & Clip

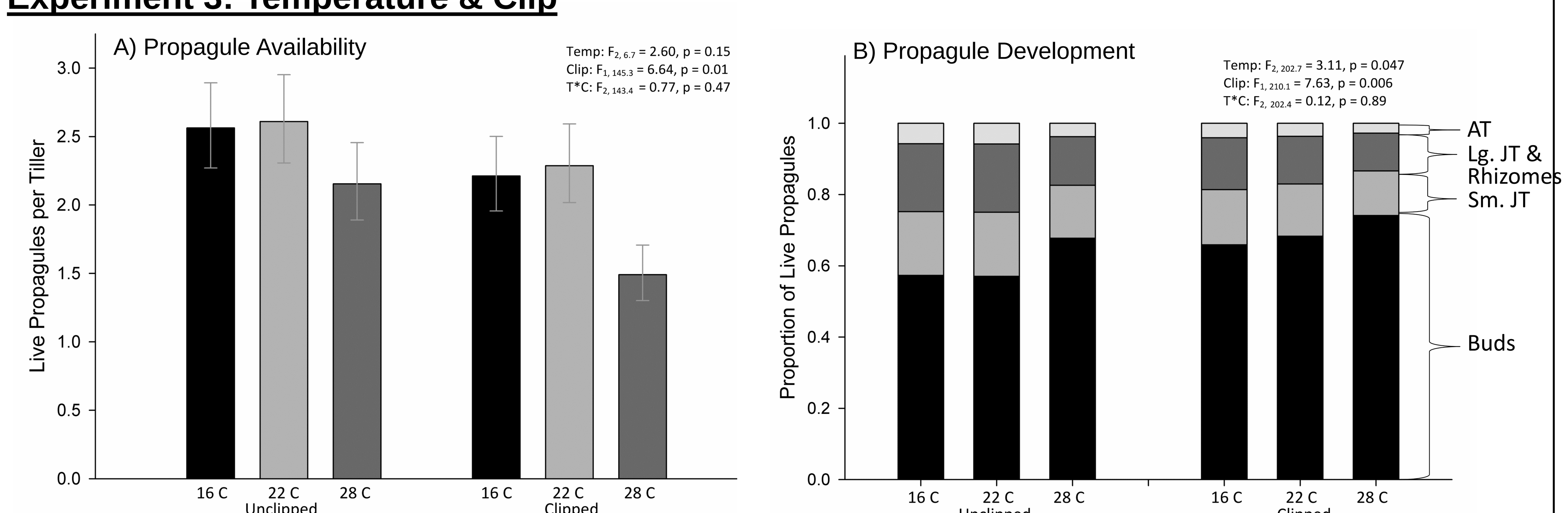

Figure 3. A) Live propagules per tiller and B) Propagule development of *P. smithii* according to temperature and clipping under well-watered conditions. Clipping reduced the number of propagules and their development in *P. smithii.* Although temperaturedid not alter the number of liver propagules per tiller, propagule development was inhibited at the highest temperature for both clipped and unclipped individuals. Note that short-term drought had no effect on bud outgrowth of either clipped or unclipped plants at the lowest temperature (Experiment 4).

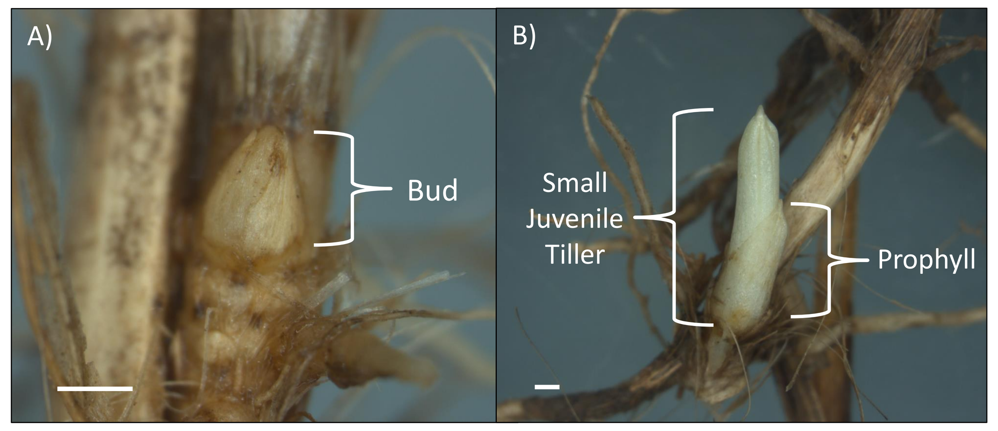

Plate 1. A) Bud and B) small juvenile tiller developmental stages of *P. smithii*. Each species had three developmental stages (bud, rhizome, and tiller). Tillers were further classified into three size classes (small juvenile (Sm JT), large juvenile (Lg JT), and adult tiller(AT)). Buds are classified as tillers once they elongate past their outer prophyll. "Live propagules" include all live buds and tillers growing from a parent tiller. Scale bars are approximately 1mm.

Discussion

• Both the bud supply and the tiller initiation and development capability of invasive *B. inermis* remained superior to native *P. smithii* under a wide range of temperatures and short-term drought. As long as tiller survival is high, *B. inermis* can readily outcompete *P. smithii* via vegetative reproduction under current and future climate scenarios.

• Unlike plants with the C_4 photosynthetic pathway , photorespiration of C_3 plants increases with temperature. C_3 plants are expected to decline in abundance in favor of C_4 plants when mean monthly temperatures exceed 22 C. Although both *B. inermis* and *P. smithii* are C_3 grasses, temperature did not affect their propagule supply or the development of *B. inermis.* However, the temperature above 22 C did reduce tiller development in *P. smithii*.

•For *P. smithii*, propagule supply and development was negatively affected by simulated grazing. Tiller initiation of clipped plants may be delayed until adequate parent tiller regrowth has occurred. In the field, resource translocation from ungrazed tillers may enable faster regrowth and tiller initiation of grazed tillers.

•Knowledge of tiller initiation from the bud bank, as it offers insight into the control of grass regeneration, will be useful in understanding the underlying mechanism by which management practices and environmental change can alter perennial grasslands.

Further work:

Tiller growth and survival is necessary to produce the next generation of buds. Therefore, tiller survival under various temperature, drought, and clipping will be examined in future greenhouse studies.

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